

NIOSH

CRITERIA FOR A
RECOMMENDED STANDARD.....

OCCUPATIONAL
EXPOSURE TO

CARBON BLACK

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

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PREFACE

The Occupational Safety and Health Act of 1970 emphasizes the need for standards to protect the health and provide for the safety of workers occupationally exposed to an ever-increasing number of potential hazards. The National Institute for Occupational Safety and Health (NIOSH) evaluates all available research data and criteria and recommends standards for occupational exposure. The Secretary of Labor will weigh these recommendations along with other considerations, such as feasibility and means of implementation, in promulgating regulatory standards.

NIOSH will periodically review the recommended standards to ensure continuing protection of workers and will make successive reports as new research and epidemiologic studies are completed and as sampling and analytical methods are developed.

The contributions to this document on carbon black by NIOSH staff, other Federal agencies or departments, the review consultants, the reviewers selected by the American Academy of Industrial Hygiene, and Robert B. O'Connor, M.D., NIOSH consultant in occupational medicine, are gratefully acknowledged.

The views and conclusions expressed in this document, together with the recommendations for a standard, are those of NIOSH. They are not necessarily those of the consultants, the reviewers selected by professional societies, or other Federal agencies. However, all comments, whether or not incorporated, were considered carefully and were sent with the criteria document to the Occupational Safety and Health Administration for consideration in setting the standard. The review consultants and the Federal agencies which received the document for review appear on pages v and vi.


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The Division of Criteria Documentation and Standards Development, National Institute for Occupational Safety and Health, had primary responsibility for the development of the criteria and recommended standard for carbon black. Craig R. McCormack, Pharm.D., of this Division served as criteria manager. SRI International developed the basic information for consideration by NIOSH staff and consultants under contract 210-77-0015.

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I. RECOMMENDATIONS FOR A CARBON BLACK STANDARD

NIOSH recommends that employee exposure to carbon black in the workplace be controlled by adherence to the following sections. The standard is designed to protect the health and provide for the safety of employees for up to a 10-hour workshift, 40-hour workweek, over a working lifetime. Compliance with all sections of the standard should prevent adverse effects of carbon black on the health of employees and provide for their safety. The standard is measurable by techniques that are valid, reproducible, and available to industry and government agencies. Sufficient technology exists to permit compliance with the recommended standard. The employer should regard the recommended workplace limits as the upper boundary for exposure and make every effort to keep the exposure as low as possible. The criteria and standard will be reviewed and revised as necessary.

The term "carbon black" refers to material consisting of more than 85% elemental carbon in the form of near-spherical colloidal particles and coalesced particle aggregates of colloidal size obtained by partial combustion or thermal decomposition of hydrocarbons. If carbon black contains polycyclic aromatic hydrocarbons (PAH's), ie, if it contains cyclohexane-extractable substances at a concentration greater than 0.1%, "occupational exposure to carbon black" is defined as any work involving any contact, airborne or otherwise, with this substance. If carbon black contains cyclohexane-extractable substances at a concentration of 0.1% or less, "occupational exposure to carbon black" is defined as any work involving exposure to carbon black at a concentration greater than half the recommended environmental limit of 3.5 mg/cu m; exposure to this carbon black at lower concentrations will not require adherence to the following sections except 2(a), 3(a), 6(b-e), 7, and 8(a). Exposure to carbon black may occur during the production, processing, distribution, storage, and use of carbon black. If exposure to other chemicals also occurs, provisions of any applicable standard for the other chemicals shall also be followed.

The recommended environmental limits are based on data indicating that carbon black may cause both transient and permanent lung damage and skin irritation. Particulate polycyclic organic material (PPOM), polynuclear aromatic hydrocarbons (PNA's), and PAH's are terms frequently encountered in the literature and sometimes used interchangeably to describe various products of the petroleum and petrochemical industries. Some of these aromatic hydrocarbons, such as 3,4-benzpyrene, pyrene, and 1,2-benzpyrene are formed during carbon black manufacture and their adsorption on the carbon black could pose a risk of cancer after exposure to the carbon black.

Section 1 - Environmental (Workplace Air)

(a) Concentration

Occupational exposure to carbon black shall be controlled so that employees are not exposed to carbon black at a concentration greater than 3.5 milligrams per cubic meter of air (3.5 mg/cu m), or to PAH's at a concentration greater than 0.1 milligram, measured as the cyclohexane-extractable fraction, per cubic meter of air (0.1 mg/cu m), determined as time-weighted average (TWA) concentrations for up to a 10-hour workshift in a 40-hour workweek.

(b) Sampling and Analysis

Environmental samples shall be collected and analyzed as described in Appendices I and II or by any method at least equivalent in accuracy, precision, and sensitivity.

Section 2 - Medical

Medical surveillance shall be made available as outlined below to all employees occupationally exposed to carbon black.

(a) Preplacement or initial examinations shall include at least:

(1) Comprehensive medical histories with special emphasis directed towards identifying existing disorders of the respiratory system, heart, and skin; comprehensive work histories to determine previous occupational exposure to potential respiratory and skin irritants and pulmonary carcinogens; and smoking and tobacco histories.

(2) Physical examination giving particular attention to the upper and lower respiratory tract, heart, skin, and mucous membranes of the oral cavity. Skin and oral examinations should pay particular attention to any pretumorous and tumorous lesions.

(3) Specific clinical tests, including at least a 35- x 42-cm posteroanterior and lateral chest roentgenogram and pulmonary function tests including forced vital capacity (FVC), forced expiratory volume in 1 second (FEV 1) electrocardiograms (ECG's) and sputum cytology.

(4) A judgment of the employee's ability to use positive and negative pressure respirators.

(b) Periodic examinations shall be made available at least annually. Roentgenographic examinations shall be made available for workers occupationally exposed to carbon black containing greater than 0.1% PAH's annually and for workers occupationally exposed to carbon black containing less than 0.1% PAH's every 3 years. These examinations shall include at least:

(1) Interim medical and work histories.

(2) Physical examination and clinical tests as outlined in (a)(2) and (a)(3) of this section.

(c) During examinations, applicants or employees found to have medical conditions, eg, respiratory impairment or dermatitis, that might be directly or indirectly aggravated by exposure to carbon black shall be counseled on the increased risk of impairment of their health from working with this substance. Applicants or employees should also be counseled on the increased risk from smoking during carbon black exposure.

(d) In the event of contamination of wounds or cuts by carbon black, the contaminated area should be promptly and thoroughly cleaned of carbon black and appropriately dressed to prevent further contamination.

(e) Pertinent medical records shall be maintained for all employees occupationally exposed to carbon black. Such records shall be kept for at least 30 years after the last occupational exposure to carbon black. These records shall be made available to the designated medical representatives of the Secretary of Health, Education, and Welfare, of the Secretary of Labor, of the employer, and of the employee or former employee.

Section 3 - Labeling and Posting

Employers shall make sure that all labels and warning signs are printed both in English and in the predominant language of non-English-reading workers. Workers unable to read the labels and posted signs provided shall be informed in an effective manner of hazardous areas and of the instructions printed on the labels and signs.

(a) Labeling

Containers of carbon black shall carry labels with the trademarks, ingredients, and information on the possible effects on human health. The pertinent information shall be arranged as follows:

**CARBON BLACK
MAY CAUSE SKIN AND RESPIRATORY IRRITATION**

Use only with adequate ventilation.
Avoid breathing dust.
Avoid contact with eyes or skin.
Report any skin irritation to your supervisor.
Store away from open flames and oxidizers - Combustion products may be harmful.

(1) If concentrations of PAH's (cyclohexane-extractable materials) exceed 0.1%, then the following statement shall be added to the label required in section 3(a) below the words carbon black:

SUSPECT CARCINOGEN

(b) Posting

(1) The following warning sign shall be posted in readily visible locations at or near all entrances to areas where carbon black is produced, stored, or handled:

**CARBON BLACK
MAY CAUSE SKIN OR RESPIRATORY TRACT IRRITATION**

Use only with adequate ventilation.
Avoid breathing dust.
Avoid contact with skin or eyes.

(2) If respirators are required for protection from carbon black or PAH's, the following statement shall be added to the sign required in Section 3(b):

RESPIRATORY PROTECTION REQUIRED IN THIS AREA

(3) If concentrations of PAH's (cyclohexane extractable materials) are above 0.1%, the following statement shall be added to the sign required in Section 3(b):

SUSPECT CARCINOGEN

Section 4 - Personal Protective Clothing and Equipment

The employer shall use engineering controls when needed to keep the concentration of airborne carbon black and PAH's at or below the environmental limits specified in Section 1(a).

(a) Respiratory Protection

(1) Compliance with the permissible exposure limits may be achieved by the use of respirators during the time necessary to install or test the required engineering controls, during performance of nonroutine maintenance or repair, and during emergencies.

(2) When a respirator is permitted or required it shall be selected and used in accordance with the following requirements:

(A) The respirator shall be selected in accordance with the specifications in Table I-1 and shall be those approved by NIOSH or the Mine Safety and Health Administration (MSHA) as specified in 30 CFR 11.

(B) The employer shall establish and enforce a respiratory protection program meeting the requirements of 29 CFR 1910.134, and shall ensure that employees use required respiratory protective equipment.

(C) Respirators specified for use in higher concentrations of carbon black or PAH's may be used for lower concentrations.

(D) The employer shall ensure that respirators are adequately cleaned, maintained, and stored in a dust free condition and that employees are instructed and drilled at least annually in the proper use, fit, and testing for leakage of respirators assigned to them.

(E) Respirators shall be easily accessible, and employees shall be informed of their location.

(b) Protective Clothing

(1) The employer shall provide and shall require employees working with carbon black to wear appropriate full-body clothing, with elastic cuffs at the wrists and ankles, gloves, and shoes, which are resistant to penetration by carbon black to minimize skin contact with carbon black.

(2) The employer shall ensure that, at the concentration of the workshift, all clothing is removed only in the change rooms prescribed in Section 7(d).

(3) The employer shall ensure that contaminated protective clothing that is to be cleaned, laundered, or disposed of is placed in a closed container in the change room.

(c) Eye Protection

Chemical safety goggles shall be provided to employees experiencing eye irritation during exposure.

TABLE I-1
RESPIRATOR SELECTION GUIDE FOR CARBON BLACK

| Concentration | Respirator Type Approved under Provisions of 30 CFR 11 |
|---|--|
| Cyclohexane extractable content less than or equal to 0.1 mg/cu m and carbon black concentration: | |
| Less than or equal to 18 mg/cu m | Single-use or quarter-mask dust respirator |
| Less than or equal to 35 mg/cu m | (1) Half-mask dust respirator (2) Any supplied-air respirator with half-mask facepiece |
| Less than or equal to 180 mg/cu m | (1) Full-facepiece high-efficiency particulate respirator (2) Any supplied-air or self-contained breathing apparatus with full facepiece |
| Greater than 180 mg/cu m or Entry into area of unknown concentration | (1) Self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode (2) Type C combination supplied-air respirator with full facepiece operated in pressure-demand mode and with auxiliary self-contained air supply |
| Cyclohexane extractable content greater than 0.1 mg/cu m regardless of carbon black concentration | (1) Self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode (2) Type C combination supplied-air respirator with full facepiece operated in pressure-demand mode and with auxiliary self-contained air supply |

Section 5 - Informing Employees of Hazards from Carbon Black

(a) The employer shall ensure that each employee assigned to work in an area where there is occupational exposure to carbon black is informed by personnel qualified by training or experience of the hazards and relevant symptoms of exposure to carbon black. Workers shall be advised that exposure to carbon black may cause transient or permanent lung damage or skin irritation, and that PAH's pose a carcinogenic risk. The instructional program shall include a description of the general nature of the medical surveillance procedures and of the advantages to The employer shall also ensure that each employee is informed of proper conditions and precautions for the production, handling, and use of carbon black. This information shall be given to employees at the beginning of employment and at least annually thereafter. Employees shall also be instructed on their responsibilities for following proper work practices and sanitation procedures to help protect the health and provide for the safety of themselves and of fellow employees.

(b) The employer shall institute a continuing education program, conducted by persons qualified by experience or training, to ensure that all employees have current knowledge of job hazards, proper maintenance and cleanup methods, and proper respirator use. As a minimum, instruction shall include the information on the Material Safety Data Sheet (Appendix III), which shall be posted in locations readily accessible to employees at all places of employment where exposure to carbon black may occur.

(c) Required information shall be recorded on the 'Material Safety Data Sheet' shown in Appendix III or on a similar form approved by the Occupational Safety and Health Administration, US Department of Labor.

Section 6 - Work Practices

(a) Control of Airborne Carbon Black

Engineering controls, such as process enclosure and local exhaust ventilation, shall be used when necessary to keep concentrations of airborne carbon black and PAH's at or below the recommended environmental limits. Ventilation systems shall be designed to prevent the accumulation or recirculation of carbon black or PAH's in the workplace environment and to effectively remove it from the breathing zones of employees. In addition to good local exhaust ventilation, maintenance of a slight negative pressure in all enclosed systems that handle dry carbon black may be needed so that when a leak develops, carbon black is contained within the system. Exhaust ventilation systems discharging to the outside air shall conform to applicable local, state, and Federal air pollution regulations. Contaminated exhaust air shall not be recirculated into the workplace. Ventilation systems should be inspected annually and shall receive regular preventive maintenance and cleaning to ensure their continuing effectiveness and maintenance of design airflows. Airflow indicators, eg, oil or water manometers, should be used for continuous monitoring of the airflow.

(b) Control of Spills and Leaks

Only personnel properly trained in the procedures and adequately protected against the attendant hazards shall be assigned to shut off sources of carbon black, clean up spills, and repair leaks. Dry sweeping should be avoided. Cleanups shall be performed by vacuuming or by hosing down with water.

(c) Handling and Storage

All direct contact with carbon black should be avoided. Care should be exercised in handling carbon black to minimize spills. Carbon black should be stored in leakproof containers and away from open flames and oxidizers. Open flames shall be prohibited in all areas of unprotected carbon black handling and storage.

(d) Waste Disposal

Waste material contaminated with carbon black shall be disposed of in a manner that does not expose employees at air concentrations above the occupational exposure limits. The disposal method must conform to applicable local, state, and Federal regulations and must not constitute a hazard to the surrounding population or environment.

(e) Confined Spaces

(1) Entry into confined spaces, such as tanks, process vessels, and tunnels, shall be controlled by a permit system. Permits signed by an authorized representative of the employer shall certify that preparation of the confined space, precautionary measures, and personal protective equipment are adequate and that prescribed procedures will be followed.

(2) Confined spaces that have previously contained carbon black shall be inspected and tested for the presence of excessive concentrations of carbon monoxide, and the temperature shall be measured.

(3) Confined spaces shall be ventilated while work is in progress to keep the concentrations of carbon black or PAH's and other air contaminants below the workplace occupational exposure limits and to assure an adequate supply of oxygen. Air from the confined spaces shall be discharged away from any work area. When ventilation cannot keep the concentrations of carbon black or PAH's and other air contaminants below the recommended occupational exposure limit, respiratory protective equipment shall be used in accordance with the provisions of Table I-1.

(4) Any employee entering confined spaces where the concentration of carbon black or PAH's may exceed the environmental limits or where other air contaminants are excessive or where oxygen is deficient shall wear appropriate respiratory protection, a suitable harness, and a lifeline tended outside the space by another employee also equipped with the necessary protective equipment. The two workers shall be in constant communication by some appropriate means.

(f) The employer shall designate all areas where there is occupational exposure to carbon black containing concentrations of cyclohexane-extractable materials greater than 0.1% as regulated areas. Only properly trained and authorized employees shall be permitted in such areas. Daily rosters shall be made of all persons who enter regulated areas.

Section 7 - Sanitation Practices

(a) Eating, preparing, storing, or the dispensing of food (including vending machines) shall be prohibited in all work areas where exposures to carbon black may occur.

(b) Smoking shall be prohibited in all the work areas where there is occupational exposure to carbon black.

(c) Employees who handle carbon black or who work in an area where they are exposed to carbon black shall be instructed to wash their hands with soap or skin cleaners and water before using toilet facilities, drinking, eating, or smoking and to shower or bathe using soap or other skin cleansers at the end of each workshift before leaving the work premises.

(d) The employer shall provide change rooms equipped with shower facilities, and separate storage facilities for street clothes and for protective clothing and equipment. The change rooms shall be in a nonexposure area.

Section 8 - Monitoring and Recordkeeping

(a) Industrial Hygiene Surveys

Each employer who manufactures or uses carbon black shall determine by an industrial hygiene survey if there is occupational exposure to it. Surveys shall be repeated at least annually and within 30 days of any process change likely to result in an increase in the concentrations of airborne carbon black, airborne PAH's, or the concentration of PAH's in the bulk carbon black. Records of these surveys, including the basis for any conclusion that the concentrations of carbon black or PAH's do not exceed the recommended environmental limits, shall be retained for at least 30 years.

(b) Personal Monitoring

If there is occupational exposure to carbon black, a program of personal monitoring shall be instituted to measure or permit calculation of the exposures of all employees.

(1) Each operation in each work area shall be sampled at least once every 6 months.

(2) In all personal monitoring, samples representative of the breathing zones of the employees shall be collected.

(3) For each determination, a sufficient number of samples shall be taken to characterize the employees' exposures during each workshift. Variations in work and production schedules and in employees' locations and job functions shall be considered in choosing sampling times, locations, and frequencies.

(4) If an employee is found to be exposed to carbon black or PAH's in excess of the recommended concentration limits and this is confirmed, the employee shall be notified of the

extent of the exposure and of the control measures being implemented. Control measures shall be initiated promptly. When they effectively reduce the employee's exposure to the TWA limit(s) or below and this is confirmed by two consecutive determinations at least 1 week apart, routine monitoring may then be resumed.

(c) **Recordkeeping**

Records of workplace environmental monitoring shall be kept for at least 30 years. These records shall include the dates and times of measurements, job function and location of the employee within the worksite, methods of sampling and analysis used, types of respiratory protection in use at the time of sampling, TWA concentrations found, and identification of the exposed employees. Employees shall be able to obtain information on their own workplace environment exposures. Workplace environmental monitoring records shall be made available to designated representatives of the Secretary of Labor and of the Secretary of Health, Education, and Welfare.

Pertinent medical records shall be retained by the employer for 30 years after the last occupational exposure to carbon black ends. Records of environmental exposures applicable to an employee should be included in medical records. These medical records shall be made available to the designated medical representatives of the Secretary of Labor, of the Secretary of Health, Education, and Welfare, of the employer, and of the employee or former employee.

II. INTRODUCTION

This report presents the criteria and recommended standard based thereon that were prepared to meet the need for preventing impairment of health from occupational exposure to carbon black. The criteria document fulfills the responsibility of the Secretary of Health, Education, and Welfare, under Section 20(a)(3) of the Occupational Safety and Health Act of 1970 to "develop criteria dealing with the toxic materials and harmful physical agents and substances which will describe...exposure levels at which no employee will suffer impaired health or functional capacities or diminished life expectancy as a result of his work experience."

After reviewing data and consulting with others, NIOSH formalized a system for the development of criteria on which standards can be established to protect the health and to provide for the safety of employees exposed to hazardous chemical and physical agents. The criteria and recommended standard should enable management and labor to develop better engineering controls and more healthful work practices, and simply complying with the recommended standard should not be the final goal.

These criteria for a standard for carbon black are part of a continuing series of criteria developed by NIOSH. The proposed standard applies to the production, processing, distribution, storage, and use of carbon black. The standard is not designed for the population-at-large and its application to any situation other than occupational exposures is not warranted. It is intended to (1) protect against the possible development of cancer and other health effects such as the irritation of skin and respiratory tract associated with occupational exposure to carbon black, (2) be measurable by techniques that are valid, reproducible, and available to industry and government agencies, and (3) be attainable with existing technology.

Based on a review of toxicologic and epidemiologic studies, there is evidence to suggest that carbon black may cause adverse pulmonary and heart changes. Carbon black also has the capability of adsorbing various PAH's, which may pose a cancer risk. Also, skin effects have been reported after persons had contact with carbon black. However, the available toxicologic and epidemiologic information has deficiencies. So further scientific research should be conducted to confirm the pulmonary, heart, and skin changes attributable to carbon black exposure. The cancer risk from carbon black exposure should also be more clearly defined.